UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/007,304	12/05/2001	Ki-Bum Kim	ASMMC.033AUS	2193

20995 7590 01/30/2003

KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

EXAMINER	
RAO, SHRINIVAS H	
ART UNIT	PAPER NUMBER
2814	

DATE MAILED: 01/30/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/007,304	KIM ET AL.	
	Examiner	Art Unit	
	Steven H. Rao	2814	

-- The MAILING DATE of this communication appears on the cover sh et with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *20 December 2002* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1 to 58* is/are pending in the application.

4a) Of the above claim(s) *1 to 34* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☐ Claim(s) *35 to 58* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *05 December 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2 .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Priority

Receipt is acknowledged of paper submitted under 35 U.S.C. 119(a)-(d), claiming priority from Korean Patent Application No. 10-2000-074025 filed on December 06, 2000 which papers have been placed of record in the file.

Information Disclosure Statement

Acknowledgment is made of receipt of Applicant's Information Disclosure Statement (PTO-1449) filed February 28, 2002.

The references on PTO 1499 submitted on 2/28/2000 are acknowledged. All the cited references have been considered. However the foreign patents and documents cited by applicant are considered to the extent that could be understood from the abstract and drawings.

Preliminary Amendment Status

Acknowledgment is made of entry of preliminary amendment filed December 20, 2002 . Therefore claims 43 to 46 and 50 –51 as amended by the amendment and claims 1 to 42 and 47 to 49, and 52 to 58 as originally filed are currently pending in the application.

Election/Restrictions

Restriction to one of the following inventions is required under 35 U.S.C. 121:

I. Claims 1-34, are drawn to a process for cooper metallization, classified in class 438, subclass 687.

II. Claims 35 to 58 are, drawn to a diffusion barrier for cooper interconnect, classified in class 257, subclass 751

Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the process as claimed can be used to make other and materially different product namely a product without stuffing the grain boundaries of the metal nitride layer with the metal compound of the reactive metal.

.During a telephone conversation with Mr. Adel Aktar (41, 394) on 12/ 20/2002 a provisional election was made without traverse to prosecute the invention of Group II, claims 35-58.

Affirmation of this election must be made by applicant in replying to this Office action.

Claims1 –34 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim

remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Drawings

The drawings filed on December 05, 2001 have been accepted by the draftsperson.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 35-42 and 45 to rejected under 35 U.S.C. 102(e) as being anticipated by Lai et al (U.S. Patent No. 6,024,175 herein after Lai).

With respect to claim 35, Lai discloses a diffusion barrier for a copper interconnect comprising layer of metal nitride (Lai fig. 2 # 4, col. 17 line 64) covered by a layer of reactive metal different from a metal in the nitride layer (Lai fig. 2 # 5, col. 18 lines 3-4), wherein the grain boundaries of the metal nitride layer are stuffed with a metal compound of the reactive metal. (Lai col. 17 lines 45 to 55).

With respect to claims 36 and 37, wherein the metal nitride layer is selected from the group consisting of titanium nitride, tungsten nitride and tantalum nitride. (Lai col. 17 liens 63-65)

With respect to claims 38-41, wherein the reactive metal is selected from the group consisting of Al, Si, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mg, Y and La. (Lai col. 18 line 48-49)

With respect to claim 42 wherein the reactive metal is selected from the group consisting of metals of group III B of the periodic table, metals of group IV B of the periodic table, metals of group V B of the periodic table and metals of group VI B of the periodic table. (Lai col. 18 line 48-49).

With respect to claim 45 wherein the different metal compound is a nitride of the reactive metal. (Lai col. 15 line 3)

With respect to claim 46 wherein the different metal compound is selected from the group consisting of aluminum nitride and silicon nitride (Lai col. 15 line 3).

With respect to claim 47 wherein the metal nitride layer is about 5 to 10 nm thick. (Lai col.18 line 3).

With respect to claim 48 wherein the reactive metal layer is about 2 nm thick. (Lai col. 18 line 8).

With respect to claim 49, additionally comprising of a second layer of metal nitride over the layer of reactive metal. (Lai fig. 9 and col. 15 lines 12 to 25).

With respect to claim 50, Aoyama discloses a diffusion barrier for a copper in a interconnect comprising : a first metal layer of metal nitride ((Lai fig. 2 # 4, col. 17 line 64) , a layer of reactive metal layer over the first layer of metal nitride (Lai fig. 2 # 5, col. 18 lines 3-4) and a second layer of metal nitride over the layer of reactive metal,

wherein the grain boundaries of the first and second metal nitride layers are stuffed with a different metal compound. (Lai fig. 9 and col. 15 lines 12 to 25).

With respect to claim 51, wherein the different metal compound is selected from the group consisting of an oxide of the reactive metal and a nitride of the reactive metal. (Lai col. 15 line 3).

With respect to claim 52, wherein the layer of titanium nitride covered by a layer of aluminum, wherein the grain boundaries of titanium nitride layer are stuffed with aluminum oxide. (Lai col. 17 lines 40 to 57).

With respect to claim 54, wherein the diffusion barrier additionally comprising a second layer of titanium nitride between the aluminum layer and a copper filler. (Lai fig. 9 and col. 15 lines 12 to 25).

With respect to claim 56, wherein the layer of metal nitride comprises titanium nitride. (Lai col. 17 line 64).

With respect to claim 57, additionally comprising a second layer of metal nitride over the layer of silicon.(Lai fig. 9 and col. 15 lines 12 to 25).

With respect to claim 58, wherein the second layer of metal nitride comprises of titanium nitride. (Lai col. 15 lines 12 to 25).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

A. Claims 43, 44 and 55 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lai et al. (U.S. Patent No. 6,204,175 herein after Lai as applied to claims above and further in view of Aoyama et al. (U.S. Patent No. 5,592,024, herein after Aoyama).

With respect to claim 43 wherein the different metal compound is an oxide of the reactive metal.

Lai describes a reactive metal but does not specifically mention an oxide of the reactive metal.

However, Aoyama in column 19 lines 39-57 describes the use of silicon dioxide as an upper interlayer insulating film in three/four wiring layer structures to form interlayer insulators at temperatures lower than the melting point o f the already formed metal lines.

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to include Aoyama's silicon dioxide as an upper interlayer insulating film in three/four wiring layer structures to form interlayer insulators at temperatures lower than the melting point o f the already formed metal lines. (Aoyama col. 19 lines 39-57).

With respect to claim 44 wherein the different metal compound is selected from the group consisting of aluminum oxide and silicon oxide. (Aoyama col. 19 lines 39-57).

With respect to claim 55, wherein the layer of metal nitride covered by a layer of silicon, wherein the grain boundaries of the metal nitride layer are stuffed with silicon oxide. (Aoyama col. 19 lines 39-57).

B. Claim 53 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lai et al. (U.S. Patent No. 6,204,175 herein after Lai as applied to claims above and further in view of Aoyama et al. (U.S. Patent No. 5,592,024, herein after Aoyama) and further in view of Dutta (U.S. Pre grant Publication No. 2002/ 64592, herein after Dutta).

With respect to claim 53, wherein the layer of titanium oxide is deposited by atomic layer deposition (ALD).

Lai and Aoyama describes several method of dry deposition like CVD PECVD, but do not specifically describe ALD.

However, Dutta in col. 3 lines 1-2 describes several dry methods including ALD to have more precise control during the deposition of thinner layers and form a thin layer of better quality than by other dry methods.

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to include Dutta's Atomic layer deposition method instead of Lai and Aoyama's dry methods like CVD to have more precise control during the deposition of thinner layers and form a thin layer of better quality than by other dry methods.

Any inquiry concerning this communication or earlier communication from the examiner should be directed to Steven H. Rao whose telephone number is (703) 306-5945. The examiner can normally be reached on Monday- Friday from approximately 7:00 a.m. to 5:30 p.m.

Any inquiry of a general nature or relating to the status of this application should be directed to the Group receptionist whose telephone number is (703) 308-0956. The Group facsimile number is (703) 308-7724.

Steven H. Rao

Patent Examiner

January 21, 2003.

SUPERVISORY PRIMARY EXAMINER
TECHNOLOGY CENTER 2800